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DEMAND SIDE IMPACTS: EXPERIMENT IN HEALTH CARE COST RECOVERY IN NIGER

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ABSTRACT

Direct user charges and indirect insurance payments are two systems of cost recovery that have been advocated and implemented in many countries. This report assesses the demand-side impacts of a 1993 pilot study in Niger under which these two cost recovery methods were implemented in different parts of the country. The experiment included three components: training and implementation of diagnostic and treatment protocols using essential drugs; improved management system capabilities; and new forms of cost recovery.

Extensive household and individual survey data were collected six months before and six months after the cost recovery experiments. Using the survey data, this report assesses whether differences in the initial demographic, health, or treatment patterns affected the outcome of the cost recovery reforms; how cost recovery and quality enhancements affected the demand for treatment from public sector providers and from informal providers; whether reported rates of illness changed; and whether the policy reforms had a disproportionate impact on lower-income households.

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ACRONYMS

CFAF	Communauté Financière Africaine (CFA) franc (Niger's currency)
HFS	Health Financing and Sustainability Project
MOH	Ministry of Health
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

Constrained economic circumstances and stagnant growth of the health sector have led many developing countries to consider cost recovery as a means to finance health care. Direct user charges and indirect insurance payments are methods of cost recovery that have been advocated and implemented in many countries. This report assesses the demand-side impacts of a pilot study conducted in Niger in 1993 in which these two methods of cost recovery were implemented in different parts of the country. This important experiment was conducted with support from the Niger Ministry of Health (MOH) and the United States Agency for International Development (USAID). This report was prepared under the auspices of the Health Financing and Sustainability (HFS) Project which was financed by USAID and for which Abt Associates Inc. is the prime contractor.

This study was undertaken in three districts in Niger — Say, Boboye, and Illéla — in which access to formal health services and the availability of essential drugs was initially quite limited. The experiment included these components: training and implementation of diagnostic and treatment protocols using essential drugs; improved management system capabilities; improved drug supply; and new forms of cost recovery. It is important to note that the experiment took place against a backdrop of declining utilization nationwide of both pharmacies and government health facilities (as demonstrated in the control site, Illéla) due to the difficulty the government's drug-importing parastatal experienced in maintaining drug supplies. Extensive household and individual survey data were collected in surveys conducted six months before and six months after the cost recovery experiments (November 1992 and November 1993) in the three districts. This survey data forms the basis of this analysis.

In the Say district, direct user charges were imposed in May 1993, nearly simultaneously with personnel training in diagnostic and treatment protocols and improved drug availability. Improved management information systems also were implemented in late 1992.

In the study district of Boboye, an insurance system was set up that included an annual health tax as well as a small patient copayment for each visit. Diagnostic and treatment protocols were initiated in Boboye in 1989, and personnel in Boboye therefore were more familiar with these protocols than personnel in Say. The district of Illéla provides an important contrast with the other sites in that the status quo (no charges) was maintained. Also, there was no training in new diagnostic and treatment protocols, and no new management systems were established.

This report uses the survey data to address the following research questions:

1. Were there any important demographic, health, or treatment patterns prior to the cost recovery reforms that should be taken into account when interpreting the changes observed after the reforms?

2. How did implementation of the direct and indirect methods of cost recovery, together with quality enhancements, change the population's probability of visiting public health facilities?

3. Do changes in the rates of treatment for certain regions appear to be due to changes in the rates of reported illness (an epidemic, for instance) or to changes in demand conditional on being ill?

4. Did the cost recovery experiment change the population's probability of seeking treatment from informal providers — for example, was there any substitution effect toward or away from the public sector?

5. Did reported rates of illness increase or decrease in districts that implemented cost recovery?

6. Did the policy reforms have a disproportionate impact on lower-income households?

This report uses two principal methodologies to address these questions. The first involves comparing means and frequencies before and after the policy change and across the three study districts. Of particular interest is whether observed changes in the rates of treatment in the districts of Say and Boboye differ significantly from those at the control district of Illéla.

The second methodology develops and estimates a statistical model of the decision making process of patients. The decision process is modeled as a three-stage process. In the first stage, the probability that a given individual reports an illness is modeled to be dependent on individual, household, and environmental variables (possibly including access to health facilities). Among those reporting an illness, the second stage of the decision process is whether to seek any treatment other than self-treatment. The third stage, conditional on a decision to seek treatment, involves the decision to seek treatment from formal providers rather than from traditional healers and other informal providers. Although the decision process is described as if it takes place sequentially, the statistical approach allows for the possibility that the three decisions are made jointly, with each decision influenced by the individual's knowledge of what subsequent decisions will be made. The parameters of the decision tree are estimated using a statistical approach called "nested logit," which is well established in the health economics literature as an appropriate basis for the analysis of decision processes of this type.

The major results and policy implications, and the issues for future research, are summarized and discussed below.

RESULTS

- The three districts of Say, Boboye, and Illéla show considerable similarity in most demographic variables such as age, male-female proportions, marital status, and levels of secondary education. The districts differ in some ways. Household size and average estimated consumption are smaller in Illéla than in the other districts. More significantly, the percentage seeking treatment before the policy change in 1993 was significantly lower in Say than in Boboye and Illéla.
- Following the policy changes in 1993, the number of people in the district of Say who sought treatment increased by 40 percent, compared to an increase of 9 percent in Illéla, and a decrease of 26 percent in Boboye. It appears that the form of cost sharing, combined with quality improvements in Say, had a favorable impact on the number of people who sought treatment.
- There appears to have been no negative impact on access, which would have shown up as an increase in the number of patients seeking treatment at home. This number declined for both Say and Boboye and increased marginally in Illéla. This is an important finding because the two districts that implemented some form of cost sharing did not experience any increase in home treatment.

- The percentage of patients seeking treatment from formal providers increased in the district of Boboye, decreased marginally in Say, and decreased appreciably in the control district of Illéla.
- Our price measure — the average payment for treatment by formal providers for the first visit — declined in all three regions, despite the policy change to increase prices. This reflects the fact that individuals were already making significant payments for pharmaceuticals and consultations before the policy change. After the change, the control district of Illéla shows the highest average price for formal care, the lowest rate of drug availability, and the lowest rate of formal treatment among the three districts.
- Prior to the policy change, the probability that an illness would be reported was lower (controlling for other covariates) in Say than in the control district of Illéla, but was higher in Boboye. Following implementation of the new policies, the situation was reversed: the probability that an illness would be reported was higher in Say than in Illéla, but was lower in Boboye than in Illéla. (There was no change in the probability of reporting illness in the control district of Illéla.)
- There were significant differences among the three regions in the rates at which people sought treatment. The introduction of a direct payment system in Say did not have a significant impact on this rate. In Boboye, where an indirect payment system (tax) was introduced, there was a large and significant increase in the probability of seeking treatment. The control site of Illéla experienced a modest but statistically insignificant reduction in the probability of seeking treatment.
- Patients with high incomes were more likely to choose formal treatment over treatment by informal providers. There was a significant shift toward formal treatment in Boboye, where an indirect payment system was introduced, and a reverse shift in the districts of Say and Illéla. The cost recovery and/or quality enhancements in Say and Boboye had only a modest effect on the probability of seeking formal treatment, while the control district experienced a sharp decline in the rate at which formal treatment was sought.
- The probability of seeking any treatment when ill was found to be significantly responsive to price. It was also the case that low-income individuals were more responsive to price changes than higher-income individuals.

POLICY IMPLICATIONS

The following policy implications are suggested by this study:

- The data suggests that the policymakers should continue the cost recovery systems currently being tried. The case against cost sharing in the health sector is usually made around the contentious issues of equity and access. This does not seem to be a concern in Niger, where the data suggests that the probability of visiting a formal/public provider increased in Boboye and did not change significantly in Say. In contrast, the probability of seeking treatment from a formal provider decreased significantly in the control district of Illéla even though rates of illness appear to have declined. These results strongly suggest that the quality enhancement offset the price effects in the two experimental districts and that the program was an improvement in the quality and accessibility of health services in those districts.

- The data suggests that there were improvements in quality that resulted in higher utilization of formal care even after cost sharing was introduced. Quality considerations therefore appear to be important in ensuring the long-term success of cost sharing. Policymakers therefore should strive to consolidate these quality improvements and to build upon them in the future.
- Introduction of the cost recovery systems changed the population's probability of seeking treatment from informal providers. Individuals reporting an illness in the two experimental districts were more likely to visit formal providers and less likely to be treated only at home or by healers and other informal providers. In contrast, in the control district of Illéla, individuals were more likely to report treatment at home or by informal providers after the policy change. The shift from informal providers to qualified medical personnel seems to be a desirable one, and policymakers should use this opportunity to reinforce such a shift.
- The rates of reported illnesses increased in Say, decreased in Boboye, and were unchanged in Illéla. Because of the short time elapsed since the cost control experiment, and the fact that the rates of treatment-seeking were increasing or remaining unchanged in the two experimental districts, it seems implausible that these changes can be attributed to the policy changes. Policymakers should closely monitor the number of reported illness, because an increase in reported illnesses, particularly more serious illnesses, that was attributable to cost sharing would be a serious cause for concern.
- Overall, the results give a reasonably favorable impression of the two experiments. The observed increase in the probability of seeking treatment from formal providers in Boboye is striking. Even though only a short time elapsed, it appears that the cost sharing system introduced in Boboye was more successful than the user-fee system introduced in Say.

FUTURE RESEARCH

This analysis highlights several areas for possible future research.

- Future research should seek to identify and isolate quality variables so that changes in patterns of utilization can be analyzed and understood in the context of interactions between quality and cost recovery. At the same time, future research also should concentrate on developing suitable tools for measuring quality. It would also help to set up a monitoring protocol, which is essential to fully understand the effects of cost recovery systems.
- Future research should develop the necessary tools for measuring the efficiency and equity of health care delivery after the introduction of user charges or insurance systems. It would be informative to examine cost variables, for instance, in evaluating the full impact of any cost recovery system.
- It would be valuable to delineate urban-rural differentials in patterns of utilization. While access and affordability may not be adversely affected by the introduction of cost sharing in urban areas, the picture may be very different in rural areas. The measures of success for any cost sharing system should take into account such regional factors.
- Future research should also consider the often significant differences between public and private facilities. Cost sharing and quality improvements in public facilities are likely to be reflected in changes in the price and the quality of care at private facilities. The changes in

utilization at private facilities (either increases or decreases) may confuse the assessment of cost sharing in public facilities.

1.0 INTRODUCTION

During 1993, an important experiment in health care cost recovery was conducted in three districts in Niger with the cooperation of the Niger Ministry of Health (MOH) and the United States Agency for International Development (USAID). This paper assesses the impact of this experiment on treatment-seeking patterns in the three districts — Boboye, Say, and Illéla — and discusses the implications of these results for national changes in cost recovery in Niger. It is important to note that the experiment took place against a backdrop of declining utilization nationwide of both pharmacies and government health facilities (as demonstrated in the control site, Illéla) due to the difficulty the government's drug-importing parastatal experienced in maintaining drug supplies.

In May 1993, the systems for cost recovery were reformed in two of the three study districts. In the Say district, a direct method of payment was implemented for outpatient treatment at government facilities, with charges of 200 CFAF per episode of treatment for adults and 100 CFAF per episode for children (under age 5). In the Boboye district, an indirect method of payment was implemented, with revenues generated primarily through an additional head tax of 200 CFAF per adult and moderate fees of 50 CFAF per episode of treatment for adults and 25 CFAF for children. In the Illéla district, there were no changes in the method of cost recovery and hence this district serves as a control site. In Illéla, the only source of revenue for public health facilities was traditional sources of government finance (direct and indirect taxes and tariffs), which were not collected through the health sector.

It is important to note that in addition to the implementation of cost sharing and diagnostic and treatment protocols, the availability of essential drugs and health management systems were improved at government health facilities. In the Boboye region, improvements in diagnostic and treatment protocols preceded the cost recovery experiment by three years; in Say, the two changes took place more or less simultaneously. Both regions saw improvements in management systems at the end of 1992. Hence the observed changes in treatment patterns in the two experimental districts cannot be attributed entirely to cost recovery but also reflect the beneficial effects of facility enhancements. Although an effort is made to separately estimate the impact of the price and quality changes, the limited facility information available makes it difficult to separately identify the two. To a great extent, the impact that is documented is the combined effect of cost sharing and quality enhancements, rather than pure demand or pure quality effects. Since there were at most only limited changes in pricing policy and quality in the control site (Illéla district), comparisons with it will be used to infer how price and quality improvements in Say and Boboye affected demand.

This paper addresses the following six questions:

1. Were there any important demographic, health, or treatment patterns prior to the cost recovery reforms that should be taken into account when interpreting the changes observed after the reforms?

2. How did implementation of the direct and indirect methods of cost recovery, together with quality enhancements, change the population's probability of visiting public health facilities?

3. Do changes in the rates of treatment for certain regions appear to be due to changes in the rates of reported illness (an epidemic, for instance) or to changes in demand conditional on being ill?

4. Did the cost recovery experiment change the population's probability of seeking treatment from informal providers — for example, was there any substitution effect toward or away from the public sector?

5. Did reported rates of illness increase or decrease in districts that implemented cost recovery?

6. Did the policy reforms have a disproportionate impact on lower-income households?

The following section of this paper briefly introduces the data. The methodology is discussed in section 3. The results are presented in section 4. The appendix discusses the various technical details.

2.0 THE DATA

The analysis in this paper uses data from household surveys conducted both before and after the cost recovery programs were introduced. Data was collected in the three districts of Say, Boboye, and Illéla, which were chosen by the Niger Ministry of Health. Say and Boboye were the districts where the experimental cost recovery systems were introduced, and Illéla was the control site.

There was an interval of twelve months between the two household surveys. The baseline survey was conducted from October to November 1992, six months before the introduction of the cost recovery systems. The final household survey was carried out in October-November 1993, six months after the intervention began. The survey instruments used were different kinds of modules. This analysis uses data collected through the household modules, curative modules, and income modules.

The sampling frame was based on the population census of 1988 and data on the distribution of health facilities in Niger in 1988. Each district was divided into two strata: one had a health facility for which five clusters ("grappes") were included, and the other had no health facility for which 29 clusters were included. A three-stage stratified cluster design was used to select households in each of the three districts.

The surveys were based on a sample of 612 households in each district for each of the two time periods. A total of 14,410 individuals (1,825 households) were interviewed in the baseline survey, and 13,051 individuals (1,834 households) were interviewed during the final survey. The two surveys took place in the same sample clusters, although different samplings of households were drawn from within these clusters.

This analysis combines data from the two sets of surveys in all three study sites. Observations with missing values were dropped if any information on the independent variables was found to be missing. Dummy variables were created for secondary education, sex, marital status, age groups, ethnicity, year, region, and region-year interaction. Continuous demographic variables include age, household size, and income. Household income is proxied by monthly household expenditures. The final analysis is based on completed interviews with 27,357 individuals in 3,646 households. Comparisons across the three regions during the baseline survey are used to assess differences across the three regions, while comparisons within the same region over time are used to assess the net effect of the cost recovery and/or quality enhancement changes.

In addition to the demographic information, responses to the household surveys were used to assign average prices, average travel times, and average self-reported drug availability measures to all individuals in the sample. The average price measure is the average for the cluster of expenditures on formal ambulatory health care treatment in the survey year. Even for individuals who made a visit to a formal provider, their price was replaced with their cluster average. The travel time measure is the average reported one-way travel time to the formal facility actually visited. The single facility quality variable was based on a self-reported measure of drug availability (1 = rarely has medication, 2 = sometimes, 3 = always has medication). Despite the fact that this is categorical variable, the simple arithmetic average was used as a convenient way to summarize this variable at

the cluster level. Previous research by Gertler et al. (1987) and Ellis and Mwabu (1993) has supported the plausible hypothesis that higher-income individuals are less responsive to price and more responsive to drug availability than lower-income individuals. To test this, interaction terms were included in the logit models. To accommodate unobserved facility quality and other variables that may have changed systematically between the two surveys, regional dummies and regional dummies interacted with a post-policy change dummy were used.

3.0 METHODOLOGY

Two statistical methods are used: univariate comparisons of sample statistics across regions and over time, and a multivariate nested logit model of the decision process underlying individual illness and treatment-seeking. For the nested logit specification, the decision tree is modeled in ***Figure 1***. Although usefully thought of as a sequential decision, the assumed specification only imposes restrictions on the correlation structure of the error terms affecting different choices. It is consistent with all stages of decisions being made simultaneously (see Ellis and Mwabu, 1991; and Train, 1986).

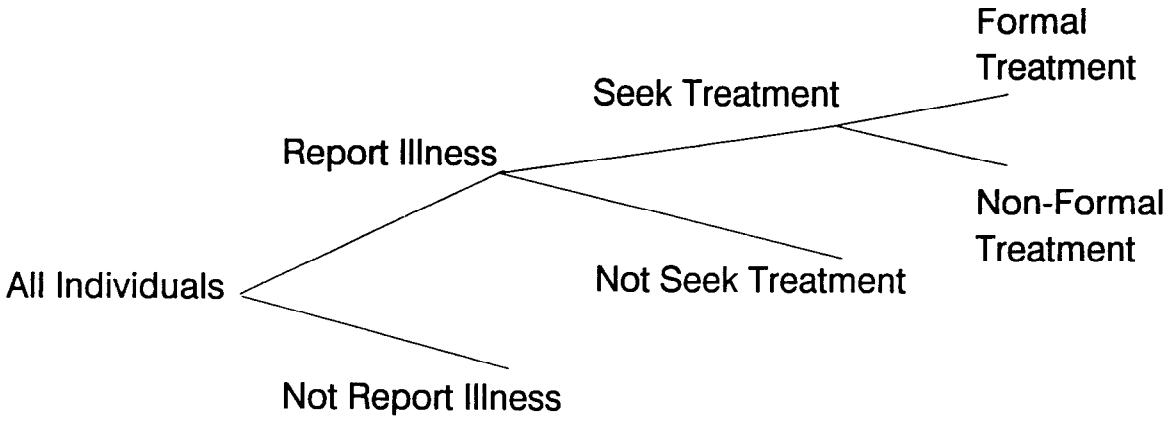
The first stage of the decision process is the decision to report an illness. This first stage is important to distinguishing whether observed changes in patterns of seeking treatment reflect differences in illness (possibly due to environmental factors that are unrelated to the policy change in the short run), or differences in treatment-seeking behavior once ill, which may be influenced by price and quality changes. Although in the long run even differences in rates of illness could be due to changes in the cost sharing and quality at government facilities, in the short run significant changes are unlikely. This stage is modeled to be dependent upon individual and household-level demographic variables; dummy variables for the region in which an individual lives; average price, travel time, and drug availability based on dummy variables for the policy changes in each region; and on a variable termed the "inclusive value," which picks up the expected utility of seeking treatment once one reports an illness.

The second stage is the decision to seek treatment from a formal provider or healer conditional on reporting an illness. For this study, formal providers are defined to include hospitals, medical centers, medical posts, rural dispensaries, "PMI1" maternity hospitals, and private clinics. The use of private clinics is extremely rare in this sample (fewer than 25 cases in our sample of 27,357 individuals), and therefore it not possible to model this choice separately. Instead, these cases were grouped with formal public facilities, even though private clinics did not change prices in line with the policy experiment. "Informal providers" are defined to include traditional practitioners (healers) and "others" (interpreted to be mostly friends, relatives, and pharmacies). Because both formal and informal treatment at home (e.g., by people other than family members) are relatively rare, and because many people treated at home also receive treatment outside of the home, there was no attempt to model home treatment separately from treatment outside of the home. Hence, for this study the decision to "seek treatment" includes the possibility of having a formal provider (doctor, midwife, or nurse) or informal provider (traditional healer or "other") treat the patient in his or her home. Treatment-seeking behavior is modeled similar to the illness-reporting decision — that is, dependent on the same set of demographic variables; average price, drug availability, and waiting times; regional dummies; and pre- and post- policy change dummy variables. Also included is an inclusive value that captures the expected value of formal treatment by qualified medical personnel.

The third stage of the decision process is the decision to seek formal rather than informal treatment. A sizable proportion of the population in all districts paid and visited traditional healers and other informal providers, and so the changes in the rates of treatment by these informal providers is important to an understanding of the total financial burden on individuals. Variables included in this last stage are the same as for the previous two stages.

Figure 1

Decision Tree Underlying Logit Model



4.0 RESULTS

4.1 BASELINE SURVEY RESULTS

Between October and December 1992, baseline surveys were conducted in 1,813 households containing 14,359 individuals in the three study districts. Summary numbers from those household surveys are shown in ***Exhibit 4.1***. The three districts show considerable similarity in many demographic variables, with virtually identical averages for age, the proportion of the population that is male, marital status, and levels of secondary education. The three districts do differ in several dimensions. Household size is smaller in Illéla than in the other two districts, and the income measure (average estimated monthly consumption expenditures) is slightly lower in Illéla and higher in Boboye than the sample average. Although days of illness are similar in the three districts, both the percentage reporting illness and the percentage seeking treatment are significantly lower in Say before the pilot tests (the "base period"). Treatment in the formal sector is quite rare in all three districts, with only 2.7 percent of individuals seeking treatment from a formal provider in the base period. The price measure was higher in Illéla (1,951 CFAF) than in Say (679 CFAF) and Boboye (792 CFAF). Reported drug availability in the base period was similar in Say and Boboye and slightly worse than in Illéla. Travel times were slightly worse in Say than in Illéla and Boboye. The characteristics of the three in the final survey (taken after the policy changes) showed similar patterns as the baseline survey (not shown).

Overall, the three districts were broadly similar prior to the policy changes, although the sample in the Say district appears to have been slightly healthier and that in Boboye slightly sicker than in the control site of Illéla. Bearing these initial differences in mind, the sample provides a nice setting for a controlled experiment for the impact of the two forms of cost sharing.

4.2 DESCRIPTIVE COMPARISON OF POLICY IMPACT IN THE THREE DISTRICTS

Exhibit 4.2 provides summary statistics of key variables before and after the policy changes in each of the three districts for all individuals seeking treatment of any kind. The first numbers to note are the large changes in the number of people seeking treatment. In the Say district, where a direct form of payment was implemented, the number of people seeking treatment increased by 40 percent, from 367 to 514. In Boboye, where a predominantly indirect payment system was implemented, the number of people seeking treatment declined by 26 percent, from 1,050 to 778. In the control site of Illéla, the number of people seeking treatment increased by 9 percent, from 488 to 532. Without controlling for any covariates, the form of cost sharing combined with quality enhancements in Say appears to have had the largest and most favorable impact on the number of people seeking treatment.

One important question is whether the cost recovery reforms decreased access, which might increase the number of people being treated only at home. This does not appear to have been the case. Among those seeking treatment of any kind, about 25 percent of the total sample reported seeking treatment outside the home from a qualified medical provider or a healer. On the other hand, only about 8 percent sought treatment at home. The majority of those seeking treatment appear to have used only a pharmacy or "other." The percentage of people who sought treatment only at home was the highest — but declined most sharply — in Say (17 percent pre-reform, 12 percent post-reform). Lower rates of home treatment were reported in Boboye (5 percent pre-, 4 percent post-) and Illéla (7 percent pre-, 8 percent post-). One important observation is that there was no increase in the number of people who were treated at home in the two districts that implemented cost sharing, in contrast with the control district of Illéla.

A second key question is whether the cost recovery experiment decreased the use of formal providers. This does not appear to have been the case. In Say, direct payment together with quality enhancement decreased the percentage of those who sought treatment from 23 percent to 21 percent. In Boboye, the number of people who sought formal treatment increased from 20 percent to 23 percent. In the control district Illéla, the percentage of people who sought formal treatment decreased from 19 percent to 12 percent.

A third key question is whether the cost recovery experiments increased the price of treatment in the study districts. It seems striking that the measure for the average price of formal treatment decreased in each of the three study districts, including Say where the policy change was to increase prices at the public facilities. Even the new fees charged in Say (200 CFAF per episode for adults, 100 CFAF for children) were well below the average reported payments in Say and Boboye before the policy intervention. This appears to indicate that substantial payments were made for pharmaceuticals and consultations by formal providers before the introduction of user fees and insurance systems, even though the public system was, in principle, free. Consistent with the objectives of the policy reforms, the measures of drug availability indicate that there were improvements in the availability of drugs in Say and Boboye, compared to a decline in drug availability in Illéla. Travel times do not appear to have changed significantly in any district. It is important to note that even in Illéla, where in principle health services at public facilities are free, patients are paying more than in the other districts (most likely for drugs that are unavailable at public facilities). In the period after the policy changes, people in the control district of Illéla had a higher average self-reported price, lower drug availability, and lower rates of formal treatment than in the other two districts.

4.3 RESULTS FROM LOGIT MODEL OF DECISION PROCESS

The preceding analysis has identified major patterns of treatment and change using univariate comparisons of means. This section reports the results of estimating a discrete choice (logit) model of the decision process underlying the treatment decision. As discussed in the methodology section, the three stages are: reporting an illness, seeking any type of treatment, and seeking formal versus traditional or informal treatment.

Results from the three-stage nested logit model are presented in ***Exhibit 4.3***. The decision to report an illness is modeled in the first stage of the decision tree, where the choice is "reporting an illness." Individuals belonging to large families are less likely to report an illness, as indicated by the negative and significant coefficient on household size. Married people and females are more likely to report an illness. Ethnic group is not a significant predictor. The coefficients on income, price, drug availability, and travel time cannot be used to infer an effect on the probability of reporting an illness because the model also includes interactions between income and the variables

for price, drug availability, and travel time. The coefficients on drug availability and on price interacted with income are each significant, which suggests that there is a relationship between these three variables and the probability of reporting an illness. Even after controlling for demographics and observed prices and drug availability, the district dummies for Say and Boboye are statistically significant: the probability that an illness will be reported is negative and significant in Say, and the reverse is true in Boboye. These coefficients changed sign after the new payment systems were introduced in Say and Boboye, perhaps picking up the impact of unobserved changes in facility quality that are not captured in the drug availability measure. Consistent with the absence of any changes in the structure of delivery in Illéla, there was no change in the probability that an illness would be reported in the control district. The coefficient on the inclusive value is statistically insignificant, suggesting that the decision to report an illness is independent of whether the individual seeks treatment for that illness.

The decision to seek treatment conditional on reporting an illness is modeled in the second level of the decision tree, where the choice variable is "seeking treatment" versus "not seeking treatment." Consistent with the results found in Ellis and Mwabu (1993), few of the demographic variables are statistically significant. Older people are more likely to seek treatment when ill than adults or children, and non-Zarma ethnic groups are less likely to seek treatment. The coefficient on price is negative and statistically significant, and the interaction term between income and price is positive and significant. Together these two parameters indicate that individuals from families with high incomes are less responsive to price than individuals from families with low incomes. The income variable, not interacted with any others, is significant and negative but cannot be easily interpreted in the presence of the interaction terms. The discussion of income is deferred until the next section, where simulations are used to identify meaningful patterns. The coefficient on the inclusive value is negative and significant. This implies that individuals that are more likely to use formal treatment are less likely to seek any treatment, which is contrary to expectations but is not implausible.

The third level of choice is between formal and informal treatment, with the choice variable being "formal treatment." Perhaps in part because the sample size is smaller than in the previous stages, none of the individual demographic variables is significant. The price term is negative and the price-time-income interaction term is positive, both as theory would predict, but the coefficients are statistically insignificant. Drug availability is negative, and the coefficient on the interaction term between drug availability and income is also negative but insignificant. In Boboye, where an indirect payment system (tax) was introduced, the district-period interaction variable has a significant positive coefficient, indicating a shift toward formal treatment. The Illéla district dummy interacted with the post-reform period dummy is negative and significant, suggesting a shift away from formal treatment in the district even after controlling for prices and drug availability. Together, the three district-time period interaction dummy coefficients suggest that the cost recovery and/or quality enhancements in Say and Boboye had modest negative and positive effects on the decision to seek formal treatment, while the control district experienced a sharp decline in rates of formal treatment-seeking.

4.4 SIMULATION RESULTS

As highlighted in the previous section, the income, price, drug availability, and travel time results from the nested logit models are not readily interpreted in terms of their policy significance. Therefore, the estimated parameters from the three-stage nested logit model are used to simulate the probabilities of each of the three decision stages. Results from the simulations are shown in ***Exhibits 4.4, 4.5, and 4.6.*** These simulations are based on a hypothetical individual with average characteristics for all variables except for the variables being simulated in each part of the table. The indirect effects of the variables through the inclusive values is taken into account in the simulations.

Comparisons of the probabilities can be used to assess the magnitude of the policy impacts and the effects on individuals of different incomes. For each simulation, we used the 10th, 50th, and 90th percentiles of the variable of interest. Hence, as shown in ***Exhibit 4.4,*** probabilities were simulated for income levels of 2,300, 7,800, and 12,900 CFAF, and prices of 2.4, 318, and 2,568 CFAF. In ***Exhibit 5.5*** the probabilities were simulated for income percentiles and for percentiles of average drug availability by district: 1.6, 2.3, and 3.0. ***Exhibit 4.6*** shows how the gross impact of the policy changes affected each income level in each of the three districts, taking into account changes in average price, drug availability, and the post-reform period dummy variables.

The simulations in ***Exhibit 4.4*** summarize the interactions between price and income on the three decisions: reporting illness, seeking treatment, and seeking formal treatment. The first part of the table indicates that neither price nor income seem to have much impact on the decision to seek formal treatment, conditional on seeking any treatment. Probabilities range from 10.8 percent for a high price, low income probability to 12.4 percent on the low price, high income simulation. The second part of ***Exhibit 4.4*** indicates that the probability of seeking any treatment is more responsive to price and income levels. The simulations suggest, roughly, a 7.5 percent increase in the probability of seeking any treatment as income varies, and a 4 percent increase as the price increases. Changes in price responsiveness are striking: for low income levels, the probability of seeking any treatment declines as prices are increased, while for high income levels, the probability is predicted to increase with price. Although contrary to usual economic theory, this is consistent with inadequately controlling for variation in facility quality, which may be correlated with price and may be highly desired by high-income individuals.

The bottom half of ***Exhibit 4.4*** presents simulations for the probability of reporting illness. Consistent with expectations, this probability is virtually unaffected by price but increases modestly with income.

Exhibit 4.5 presents a similar set of simulations for various levels of drug availability, each considered for three income levels. The probability of seeking formal treatment is negatively related to the average drug availability and does not show a meaningful difference across income levels. Drug availability has a large effect on the decision to seek formal treatment, but this effect differs by income level: it causes a nearly 14 percentage point increase in the probability of seeking any treatment for the highest income level versus only a 2.1 percentage point difference for the lowest income level. Income and drug availability predict a more than 18 percentage point difference in the probability of seeking any treatment. The final section of ***Exhibit 5.5*** indicates that higher drug availability appears to reduce the rate at which illness is reported, with approximately a 3 percentage point reduction in the probability of reporting illness at the 90th versus the 10th percentile level of drug availability.

Exhibit 4.6 summarizes the total impact of the policy change, including changes in prices, drug availability, and unobserved variables captured by the district-level dummies interacted with the post-reform period dummy. This table provides the best picture of the overall impact of the policy changes on individuals with different household incomes, holding constant all other observed characteristics. The first part of ***Exhibit 4.6*** indicates that the probability of seeking formal care conditional on seeking any care was virtually unchanged for all income levels in Say; it increased approximately 5 percentage points in Boboye; and it decreased approximately 6 percentage points in Illéla. In each district, the reduction in use of formal treatment when any treatment was sought was relatively independent of income levels.

The second part of ***Exhibit 4.6*** indicates that the policy changes also had a large impact on the probability of seeking any treatment when ill. There was a small decrease (2 percentage points) in this probability in Say, about a 4 percentage point increase in Boboye, and a 9 percentage point increase in Illéla. These changes are similar across different income levels.

The third section of ***Exhibit 4.6*** indicates the probability that an illness would be reported in each of the three districts for each income level, before and after the policy change. The simulations indicate a large increase in this measure in Say of 9 percentage points, a decline in Boboye of 5 percentage points, and a small increase in Illéla of 1 percent. With only three districts and two time periods, it is not possible to detect whether these large changes in rates of reported illness are related to the policy changes or due to exogenous influences, such as epidemics.

Several findings from the simulations are worth contrasting with the previous literature. Price effects are significant, but relatively small — noticeably smaller than the income effects on the impact of seeking formal treatment and seeking any treatment. Households with the lowest incomes have roughly a 2 percentage point lower probability of seeking formal treatment (given any treatment) than households in the highest income level, a difference that is small in comparison to those observed in studies of other regions (e.g., Ellis, McInnes, and Stephenson, 1994; and Ellis and Mwabu, 1993). On the other hand, income is more strongly related to the probability of seeking any treatment, with a roughly 10 percentage point change between low and high income levels.

4.5 DISCUSSION

In the introduction to this paper we identified six questions to be answered. This section discusses the answers to these questions based on the empirical results, and then discusses the policy implications of the results.

- The first question was whether there were any important differences in the demographic, health, or treatment patterns in three districts that need to be taken into account when considering the impact of the policy changes. Our univariate analysis has suggest that the three districts were similar on most demographic variables, although the Say district was slightly healthier and the Boboye slightly sicker than Illéla.
- How did the cost recovery experiment change the population's probability of visiting public providers? Strikingly, we found that the probability of visiting a formal/public provider increased in Boboye and did not change significantly in Say. In contrast, the probability of treatment by a formal provider decreased significantly in the control district of Illéla, although rates of illness also appear to have declined in that district. These results strongly suggest that the quality enhancement offset the price effects in the two experimental districts. The fact that the rates increased or did not decline in the two experimental districts is a very positive sign that the program was an improvement in the quality and accessibility of health services in those districts.
- Were the observed changes in rates of visits due to changes in reported illness? Probably not. Reported rates of illness went down significantly in Boboye and up significantly in Say, in the opposite directions of the rates of treatment. Hence, illness patterns were in the opposite rather than the same direction as changes in treatment.
- Did the experiment change the probabilities of seeking treatment from informal providers? Yes, in a desirable direction. Individuals reporting an illness in the two experimental districts were more likely to visit formal providers and less likely to be treated only at home or by healers and other informal providers. In contrast, in the control district of Illéla, individuals were more likely to report treatment at home or by informal providers after the policy change.
- Did reported rates of illness change? The univariate analysis and logit model both indicate that rates of reported illness increased substantially in Say, decreased in Boboye, and were

virtually unchanged in Illéla. Because of the short elapsed time since the pilot tests began, together with the fact that rates of visits were increasing or unchanged in the two experimental districts, it seems implausible that these changes can be attributed to the policy changes. They do suggest the need for further monitoring of this important trend, however.

- Did the policy reforms have a disproportionate impact on lower-income households? Low-income individuals were found to be more responsive to price changes than higher-income individuals.

Overall, the results give a reasonably favorable impression of the two experiments. In neither case is there evidence of serious reductions in access or increases in cost. Particularly notable is that in Say, with moderate cost sharing, the observed decline in rates of visits is statistically insignificant. For this to be true, the quality at the public facilities must have increased significantly. The observed increase in the probability of formal visits in Boboye is also striking. Both contrast with the control district of Illéla, where one can infer a decrease in quality given that prices did not change while visit rates fell substantially.

EXHIBIT 4.1
SAMPLE CHARACTERISTICS IN THE THREE DISTRICTS,
BEFORE POLICY CHANGES: ALL INDIVIDUALS

	SAY	BOBOYE	ILLÉLA	TOTAL
Number of households Number of individuals	597 4,685	609 5,566	607 4,108	1,813 14,359
Size of household	10.46 (5.36)	11.53 (5.84)	8.971 (5.587)	10.45 (5.71)
Age	20.82 (18.73)	20.46 (18.50)	20.60 (17.93	20.62 (18.41)
Sex: male	.5014 (.500)	.4822 (.499)	.4880 (.4950)	.4901 (.4999)
Married	.3565 (.479)	.3426 (.4746)	.3671 (.4821)	.3541 (.4782)
Secondary school	.0171 (.129)	.0190 (.1367)	.0071 (.0837)	.0149 (.1214
Non-Zarma	.7791 (.414)	.2045 (.4033)	.9956 (.0661)	.6183 (.4858)
Income (thousands of CFAF)	12.95 (13.8)	14.97 (18.41)	11.57 (12.95)	13.34 (15.61)
Reported illness	.1372 (.344)	.2432 (.4291)	.2186 (.4133)	.2016 (.4012)
Days ill	11.19 (10.6)	11.30 (10.36)	11.98 (10.41)	11.36 (10.44)
Seeking treatment	.0783 (.268)	.1886 (.3913)	.1188 (.3236)	.1326 (.3392)
(continued on next page)				
Treatment at home	.0156 (.123)	.0099 (.0989)	.0088 (.0932)	.0144 (.1062)
Treatment out of home	.0201 (.140)	.0456 (.2087)	.0314 (.1744)	.0332 (.1792)

EXHIBIT 4.1
SAMPLE CHARACTERISTICS IN THE THREE DISTRICTS,
BEFORE POLICY CHANGES: ALL INDIVIDUALS

	SAY	BOBOYE	ILLÉLA	TOTAL
Treatment by healer	.0094 (.096)	.0129 (.1130)	.0122 (.1097)	.0115 (.1069)
Formal treatment	.0188 (.135)	.0377 (.1906)	.0241 (.1534)	.0276 (.1639)
Total expenditures on illness	396.5 (1,400.)	788.3 (2,540.)	795.0 (2,863.)	662.5 (2,350.)
Price	679 (1,089.)	792 (764.)	1,951 (2,983.)	1,087 (1,860.)
Drug availability	2.03 (.568)	2.05 (.537)	2.38 (.420)	2.14 (.539)
Travel time	149 (109.)	122 (79.7)	123 (83.2)	130.9 (92.1)
Price × income	10,313 (24,417.)	12,427 (23,480)	21,906 (49,474.)	14,449 (33,636.)
Drug availability × income	27.0 (31.5)	30.6 (39.0)	28.0 (33.7)	28.7 (35.2)
Travel time × income	1,720 (2,349)	1,607 (2,320)	1,355 (1,961)	1,572 (2,238)

EXHIBIT 4.2
SAMPLE CHARACTERISTICS IN THE THREE DISTRICTS, PRE- AND POST-POLICY CHANGE: INDIVIDUALS SEEKING TREATMENT ONLY

	SAY		BOBOYE		ILLÉLA	
	PRE-	POST-	PRE-	POST-	PRE-	POST-
Number of households Number of individuals	133 367	324 514	183 1,050	380 778	134 488	327 532
Size of household	8.92 (4.54)	8.708 (5.157)	11.11 (5.75)	9.479 (4.685)	8.596 (4.919)	7.757 (3.938)
Age	22.96 (20.77)	20.61 (20.86)	22.09 (21.11)	22.96 (21.69)	23.02 (20.90)	22.09 (20.58)
Sex: Male	.5123 (.5005)	.4883 (.5003)	.4457 (.4973)	.4704 (.4994)	.5061 (.5005)	.5038 (.5005)
Married	.3951 (.4895)	.3444 (.4756)	.3619 (.4808)	.4075 (.4918)	.4119 (.4927)	.4173 (.4938)
Secondary School	.0191 (.1369)	.0233 (.1511)	.0209 (.1433)	.0129 (.1127)	.0164 (.1271)	.0056 (.0749)
Non-Zarma	.7411 (.4386)	.7859 (.4105)	.1981 (.3988)	.2108 (.4081)	1.000 (.000)	.9963 (.0613)
Income (thousands of CFAF)	13.63 (12.29)	16.43 (20.93)	16.51 (18.79)	15.29 (19.51)	12.92 (15.46)	10.01 (11.17)
Days ill	11.82 (11.02)	11.91 (11.50)	11.56 (10.65)	11.25 (10.66)	13.67 (10.93)	13.90 (11.63)
Treatment at home	.1717 (.3776)	.1226 (.3283)	.0505 (.219)	.0373 (.1896)	.0697 (.2549)	.0771 (.2669)
Treatment out of home	.2343 (4242)	.2043 (.4036)	.2371 (.4255)	.2429 (.4291)	.2561 (.437)	.1561 (.3632)
Treatment by healer	.1008 (.3015)	.0661 (.2488)	.0648 (.2462)	.0373 (.1896)	.0984 (.2982)	.0695 (.2546)
Formal treatment	.2262 (.4189)	.2082 (.4064)	.1981 .(3988)	.2301 (.4212)	.1947 (.3964)	.1241 .(3299)
Price	794 (1,080)	685 (1,151)	864 (790)	553 (667)	2,101 (2,737)	717 (1,266)
Drug availability	2.08 (.545)	2.35 (.412)	2.01 (.507)	2.64 (.271)	2.3 (.40)	2.20 (.58)
Travel time	129 (112)	139 (.103)	118 (82.7)	121 (80.0)	127 (85.6)	125 (83.1)
Price × income	11,297 (18,581)	11,622 (25,050)	14,653 (24,283)	9,774 (28,499)	31,977 (72,031)	7,147 (17,311)
Drug availability × income	29.5 (29.6)	37.8 (47.1)	32.9 (38.4)	39.8 (49.9)	31.1 (42.4)	21.3 (24.3)
Travel time × income	1,532 (2,122)	1,852 (2,815)	1,703 (2,359)	1,801 (3,521)	1,663 (2,642)	1,341 (2,290)

EXHIBIT 4-3
NESTED LOGIT RESULTS FOR THE TREATMENT-SEEKING PROCESS

	Reporting illness	Seeking treatment	Formal versus informal
Household size	-0.0366[c] (0.00352)	-0.00483 (0.00691)	0.00972[a] (0.00919)
Old age	0.106[a] (0.0639)	0.330[b] (0.118)	-0.284[a] (0.179)
Adult	-0.399[c] (0.0499)	-0.0304 (0.107)	-0.0298 (0.159)
Sex: Male	-0.888[c] (0.229)	-0.0241 (0.301)	0.438[a] (0.337)
Married	0.300[c] (0.0503)	-0.0873 (0.104)	0.131 (0.158)
Secondary school	-0.0291 (0.137)	0.367[a] (0.364)	0.314[a] (0.291)
Non-Zarma	-0.0360 (0.0482)	-0.338[c] (0.0919)	-0.0942 (0.118)
Household income	(0.000315 (0.00453)	-0.0236[b] (0.00974)	0.00782 (0.00945)
Say District (Pre-Dummy)	-0.547[c] (0.0619)	-0.0456 (0.113)	0.0584 (0.190)
Boboye District (Pre-Dummy)	0.244[b] (0.0808)	0.818[c] (0.124)	-0.290[a] (0.184)
Price	0.0000160 (0.0000128)	-0.0000724[b] (0.0000266)	-0.0000141 (0.0000405)
Drug availability	-0.136[c] (0.0426)	(0.0300 (0.822)	-0.298[b] (0.116)
Travel time	0.000287 (0.000328)	0.000464 (0.000716)	-0.0123[c] (0.00105)
Income × price	0.00000197[b] (0.000000778)	0.00000496[b] (0.00000193)	0.00000131 (0.00000191)
Income × travel time	0.0000233 (0.0000124)	0.0000363 (0.0000305)	0.00000790 (0.0000409)
Income × drug availability	0.469 (0.00192)	0.0133[b] (0.00431)	-0.00168 (0.00414)
Say District × Post Dummy)	0.473[c] (0.0598)	0.122 (0.111)	0.0607 (0.177)
Boboye District × Post Dummy	-0.250[c] (0.0551)	0.120 (0.119)	0.556[c] (0.145)

(continued on next page)

EXHIBIT 4-3
NESTED LOGIT RESULTS FOR THE TREATMENT-SEEKING PROCESS

	Reporting illness	Seeking treatment	Formal versus informal
Illéla District × Post Dummy	0.119 (0.0642)	0.292[b] (0.105)	-0.605[b] (0.195)
Inclusive value	-0.140 (0.156)	-1.542[c] (0.407	
Loglike	-13,607.54	-3,348.64	-1,593.70
Sample size	3,722	15,618	27,357

Notes:
a. Weakly significant (t > 2).
b. Significant (2 < t < 3.5).
c. Very significant (t > 3.5).

EXHIBIT 4.4
SIMULATION RESULTS BY PRICE AND INCOME

INCOME (thousands of CFAF)		PRICE		
		10th percentile	50th percentile	490th percentile
		2	317	2,568
PROBABILITY OF SEEKING FORMAL TREATMENT CONDITIONAL ON SEEKING ANY TREATMENT Percentile level:				
10th	2.3	11.1	11.0	10.8
Median	7.8	11.3	11.3	11.2
90th	28.8	12.4	12.5	13.1
PROBABILITY OF SEEKING TREATMENT CONDITIONAL ON REPORTING ILLNESS Percentile level:				
10th	2.3	52.3	51.9	48.5
Median	7.8	53.9	53.7	51.8
90th	28.8	59.9	60.4	64.1
PROBABILITY OF REPORTING ILLNESS Percentile level:				
10th	2.3	23.4	23.5	24.3
Median	7.8	23.8	24.0	25.3
90th	28.8	25.5	26.0	29.3

EXHIBIT 4.5
SIMULATION RESULTS BY DRUG AVAILABILITY AND INCOME

INCOME (thousands of CFAF)		DRUG AVAILABILITY		
		10th percentile	50th percentile	90th percentile
		1.63	**2.29**	**3.0**
PROBABILITY OF SEEKING FORMAL TREATMENT CONDITIONAL ON SEEKING ANY TREATMENT Percentile level:				
10th	2.3	13.0	10.9	9.0
Median	7.8	13.5	11.3	9.2
90th	28.8	15.3	12.6	10.1
PROBABILITY OF SEEKING TREATMENT CONDITIONAL ON REPORTING ILLNESS Percentile level:				
10th	2.3	50.0	51.0	52.1
Median	7.8	51.0	53.2	55.6
90th	28.8	54.8	61.5	68.2
PROBABILITY OF REPORTING ILLNESS Percentile level:				
10th	2.3	25.3	23.7	22.0
Median	7.8	25.9	24.3	22.6
90th	28.8	28.4	26.7	25.0

EXHIBIT 4.6
SIMULATION RESULTS BY DISTRICT, TIME PERIOD, AND INCOME

INCOME (thousands of CFAF)		SAY		BOBOYE		ILLÉLA	
		PRE-(%)	POST-(%)	PRE-(%)	POST-(%)	PRE-(%)	POST-(%)
PROBABILITY OF SEEKING FORMAL TREATMENT CONDITIONAL ON SEEKING ANY TREATMENT							
10th percentile	2.3	11.3	11.1	10.4	15.7	12.3	6.6
Median	7.8	11.6	11.4	10.7	16.1	12.7	6.8
90th percentile	28.8	13.1	12.6	12.2	17.8	13.0	6.9
PROBABILITY OF SEEKING TREATMENT CONDITIONAL ON REPORTING ILLNESS							
10th percentile	2.3	53.5	51.3	50.4	54.5	49.9	58.2
Median	7.8	55.6	53.8	52.5	56.7	51.9	60.4
90th percentile	28.8	63.3	62.4	60.3	65.2	59.8	68.4
PROBABILITY OF REPORTING ILLNESS							
10th percentile	2.3	22.8	31.2	24.9	19.8	23.8	25.1
Median	7.8	23.4	31.8	25.6	20.3	24.4	25.7
90th percentile	28.8	26.0	34.5	28.3	22.3	27.1	28.1

TECHNICAL APPENDIX

Section 1 introduces and explains the model used in the study. Issues of empirical specification and estimation are taken up in section 2. The software used in estimation of the nested logit model is briefly introduced in section 3, and the advantages and disadvantages of using this software to estimate nested logits are discussed in section 4.

1. THE MODEL

Important experiments in health care cost recovery were conducted in three districts of Niger in 1993, with the cooperation of the Niger Ministry of Health and USAID. The method of cost recovery was reformed in two of the three study districts in Niger. In the Say district, a direct method of payment was implemented for outpatient treatment at government facilities, with charges of 200 CFAF per episode of treatment for adults and 100 CFAF per episode for children (under age 5). In the Boboye district, an indirect method of payment was implemented, with revenues generated primarily through a regional tax of 200 CFAF per household and moderate fees of 50 CFAF per episode of treatment for adults and 25 CFAF for children. In the Illéla district, no change in the method of cost recovery was implemented, and hence it serves as a control site. In Illéla, the only sources of revenue for public health facilities were traditional sources of government finance (direct and indirect taxes and tariffs), not collected through the health sector. This paper makes an assessment of the various cost recovery methods experimented in these districts.

Demand for health care can be defined as a "quantity of a particular type of service that people are willing to obtain over a given period of time" (Bitran, 1993). More important than quantity of health care, however, is the discrete phenomenon of "seeking care." In this specification the values taken by the dependent variable are merely a coding for some qualitative outcome, where the mutually exclusive choices may be "seek treatment from provider j" and "seek treatment from provider k." The choice of provider would naturally be conditional on the decision to "seek treatment" or "not seek treatment," which in turn would be conditional on being "ill" or being "not ill." We have described this sequence in ***Figure 1***. Estimation of demand thus takes the form of estimating these marginal and conditional probabilities (see Bitran, 1993). These probabilities are monotonic to indirect utility functions, V_i. The indirect utility functions can be expressed as

$$V_i=f(P_j,Q_j,Y_i,HS_i,MS_i,S_i,A_i,E_i) \qquad (1)$$

where
- P_j: Price of health care provided by j
- Q_j: Quality of health care provided by j
- Y_i: Income of health-care demander, individual i
- Hs_i: Household size of individual i
- Ms_i: Marital status of individual i
- S_i: Schooling of individual i

A_i: Age of individual i

E_i: Ethnicity of individual i

Estimating health care demand using prices and provider quality measures permits the calculation of price and quality elasticities. This is particularly important since one of the objectives of the new cost recovery methods was explicitly to increase facility quality. Unfortunately, detailed facility quality variables were not available.

Controlling for quality changes is particularly important in the sample because it is known to have changed. The quality and availability of resources was intentionally upgraded at various health facilities in the two experimental regions. Hence the observed changes in treatment patterns in these districts cannot be attributed entirely to cost recovery but also reflect the beneficial effects of facility enhancements. For this analysis, the only information available about health facility quality is the availability of drugs. Although this measure is included, along with price, it is likely that the impacts of the effect of cost sharing and quality enhancements are not fully captured by these two variables. Hence dummy variables are also included for before and after the policy change, interacted with the district dummies.

The dummy variables capture the impact of unmeasured policy changes in each district. Price and drug availability estimates are used to assess the sensitivity of demand to these variables. However, it is likely that they only imperfectly measure these impacts because of unmeasured changes in facility quality. Since there were no major changes in either prices or quality in the control site of Illéla district, comparisons across the three districts, taking into account price and drug availability changes, are used to infer how the policy changes affected demand. Comparisons across the three districts in the base period are used to assess differences across the three districts, while comparisons within the same district over time are used to assess the net effect of the cost recovery/quality enhancement changes.

2. EMPIRICAL SPECIFICATION AND ESTIMATION

This section examines the merits of the nested logit specification over linear probability models in handling cases described in the previous section. First, some of the problems associated with using linear probability models are examined, and this indicates that logits be used as one possible solution. Finally, the constraints posed by conditional decision-making are examined, and the basis for using nested logits is established.

Qualitative considerations in regression equations are usually examined by including dummy variables. If a dummy variable, D, is regressed on a single explanatory variable, x, the resultant regression equation is

$$D_i=\alpha_0+\alpha_1 x_i+\varepsilon_i \qquad (5)$$

As represented, the condition for which D=1 is evaluated as a function of the dependent variable x.

Assuming that $E(\varepsilon_i)=0$, the expected value of (5) can be written as

$$E(D_i)=\alpha_0+\alpha_1 x_i \qquad (6)$$

The dependent variable can take only two values, 0 or 1. Denoting the probability that $D_i=1$ by $p(D_i=1)$, the right hand side of (4) can be represented as

$$E(D_i)=p(D_i=1)\cdot 1 + p(D_i=0)\cdot 0, \text{ or}$$
$$E(D_i)=p(D_i=1) \qquad (7)$$

The expected value of the dummy dependent variable therefore denotes the probability for which D=1 occurs. (7) can be rewritten as

$$p(D_i=1)=\alpha_0+\alpha_i x_i \qquad (8)$$

Least squares estimation of the linear probability model as depicted in (5) raises several problems. First, the errors from this equation are not normally distributed, though for large samples the central limit theorem applies. The least squares estimators however, retain their property of unbiasedness; what is affected is statistical inference from this equation. Second, the errors in (5) are heteroskedastic. This affects the minimum-variance property of the estimators. Finally, and perhaps most seriously, predicted values from this equation, which are estimated probabilities, can lie outside of the bounds for probabilities, 0 and 1. For these reasons, the linear probability model tends not to fit a scatter of data points well, resulting in relatively low values for R^2.

To remedy these deficiencies, an alternative model is needed which contains the predicted values within reasonable limits, and does not encounter the same problem with equation errors as the linear probability model.

One approach that has been adopted is to assume that the right-hand side of (5) is related to an unobserved variable, z_i, such that

$$z_i=\alpha_0+\alpha_1 x_i \qquad (9)$$

In this specification, $\alpha_0+\alpha_1 x_i$ corresponds to $E(z_i)$, and not to $E(D_i)$, as it did for (5). A relationship between (5) and (9) is established by associating an observed dummy variable with the unobserved variable z_i. It is assumed for this purpose that a threshold value exists for z_i, such that the closer z_i is to its threshold, T^*, the more likely is it for D=1. The observed values for the dummy variable are thus defined as follows:

$$D_i = \begin{cases} 1 \text{ if } z_i > T^* \\ 0 \text{ otherwise} \end{cases} \qquad (10)$$

Different models utilize different probability distributions to characterize the stochastic errors in (9). The error assumption usually involves a specific cumulative distribution function, since if the threshold value T^* is made equal to 0, then

$$D_i = \begin{cases} 1 \text{ if } z_i > 0 \\ 0 \text{ otherwise} \end{cases} \qquad (11)$$

Then,

$$p(D_i=1) = p(\alpha_0+\alpha_1 x_i+\varepsilon_i>0)$$
$$= p(\varepsilon_i>-(\alpha_0+\alpha_1 x_i))$$
$$= 1-P[-(\alpha_0+\alpha_1 x_i)] \quad (12)$$

For a symmetric probability density, function (12) can be written as

$$p(D_i=1) = P(\alpha_0+\alpha_1 x_i) \quad (13)$$

In the logit model the cumulative probability density function is represented by the logistic density function. In this case (13) becomes

$$p(D=1)=1/\{1+\exp(-[\alpha_0+\alpha_1 x_i+\varepsilon_i])\} \quad (14)$$

Three properties of the logit choice probabilities are important to note. First, each of the probabilities is necessarily between 0 and 1. This effectively takes care of the major problem with linear probability models discussed earlier. Second, the choice probabilities necessarily sum to 1, which follows from the fact that the choice set is exhaustive and the alternatives are mutually exclusive. Third, logit probabilities exhibit the "independence from irrelevant alternatives" property, or IIA, a property which may not be desirable in all situations. This is discussed in a little more detail below.

In the logit formulation, the ratio of the choice probabilities for two alternatives does not depend on any other alternative. The ratio of probabilities is necessarily the same, no matter what other alternatives may be available. This property is clearly undesirable in many situations. Consider, for example, a situation where the patient has a choice of seeking no treatment or treatment by a healer, and both choices have the same representative utility. Because the representative utilities are equal, the ratio of choice probabilities is 1, i.e., P(no treatment,(NT))=1/2 and P(Healer,(H))=1/2.

Suppose now that the patient has a choice of seeking treatment by a physician, (P), and that the patient considered treatment by a physician as being exactly the same as treatment by a healer. However, since in the logit model the ratio P(NT)/P(H) is the same independent of the existence of other alternatives, this ratio remains constant at 1. The only probabilities for which P(NT)/P(H)=1 and P(H)/P(P)=1 are P(NT)=P(H)=P(P)=1/3, which is what the model predicts. In real life, however, one would expect the original probability of seeking treatment by a healer to be split between seeking treatment by a healer or a physician. In this case, the logit model overestimates the probability of taking either form of treatment and underestimates the probability of seeking no treatment.

One way to deal with this problem is to use a probit specification. This approach, feasible though complex, does not exploit the fact that IIA does hold between some pairs of alternatives. Another qualitative choice model, called the nested-logit model, is used to handle such situations.

Nested logits can be used when it is possible to partition into subsets the set of alternatives available to the decision maker. This partitioning is done such that the property of IIA holds for all the alternatives in any subset, but not across subsets.

Formally, the nested-logit model is specified as follows. Let the set of alternatives available be characterized by Æ. Let there be k partitions of Æ, denoted by B(1),...,B(k). Further, let the utility received from alternative j in subset B(k) be

$$U_j=V_j+\varepsilon_j \qquad (15)$$

where V_j is the observable component. It is assumed that ε_j are distributed in accordance with a generalized extreme value distribution. The joint cumulative distribution of the random variables, ε_j, can be shown to be a generalization of the distribution that gives rise to the logit model. For logit each ε_j is independent with a univariate extreme value distribution; for a nested logit, the marginal distribution of each ε_j is univariate extreme value, but all ε_j within each subset are correlated with each other. For any i and j in different subsets, there is no correlation between ε_i and ε_j.

It can also be shown (see McFadden, 1978) that when there is no correlation between ε_j within a subset, then the choice probabilities are simply logit. For this reason, the nested logit can be seen as a generalization of logit that allows for particular patterns of correlation in unobserved utility.

The choice probabilities can be expressed in an alternative fashion that is quite simple and readily interpretable. Let utility be expressed as

$$U(j)=W(k)+\lambda(k)\,Y(k)+\varepsilon_j \qquad \forall\ j\in B(k) \qquad (16)$$

where W(k) is the mean of V(j) over all alternatives in subset B(k), Y(k) is the deviation of V from the mean, and lambda denotes a measure of the correlation of the unobserved utility within the subset B(k).

Let the probability of choosing alternative j in subset B(k) be expressed as the product of the probability that an alternative within the subset B(k) is chosen and, given that B(k) is chosen, alternative j is chosen. This is represented by

$$P_j=P_{j/B(k)}\cdot P_{B(k)} \qquad (17)$$

where $P_{j/B(k)}$ is the conditional probability of choosing alternative j given that an alternative in the subset B(k) is chosen, and $P_{B(k)}$ is the marginal probability of choosing an alternative in B(k).

One reason for representing the probability as a product of conditional and marginal probability is that the conditional and marginal probabilities take the form of logits. In particular, the conditional and marginal probabilities can be written as

$$P_{j/B(k)}=\frac{\exp[Y_j(k)]}{\sum_{l\in B(k)}\exp[Y_l(k)]} \qquad (18)$$

$$P_B(k) = \frac{\exp[W(k) + \lambda(k) I(k)]}{\sum_{l=1}^{k} \exp[W(l) + \lambda(l) I(l)]} \quad (19)$$

where

$$I(k) = \ln \sum_{i \in B(k)} \exp[Y(k)] \quad (20)$$

In other words, the conditional probability of choosing j, given that the alternative B(k) is chosen, is expressed as a logit with variables that vary over alternatives within each subset entering representative utility in the logit specification. Similarly, the marginal probability of choosing an alternative in B(k) is also expressed as logit with the variables that vary over subsets of alternatives. The term I denotes the average utility that the decision maker can expect from the alternatives within the subset and is also known as the "inclusive value."

Accordingly, this the technique of nested logit was used in computing the probability that an illness is reported, the conditional probability of seeking care when illness is reported, and the conditional probability of choosing either a formal or an informal provider, given that some form of treatment is sought.

3. THE ECONOMETRIC SOFTWARE USED

The nested logit model was estimated using the LIMDEP version 6.0 software. LIMDEP uses a two-step "limited-information" estimator. First, the conditional probability, $P_{j/B(k)}$ is estimated. The inclusive value is kept as a variable, and in the second step, P_j is estimated using the inclusive value as a variable. Each step therefore reduces to a discrete-choice estimation.

Data for the nested logit model needs to be arranged in a manner that allows the program to choose the relevant rows at each level of estimation. The major advantage of LIMDEP over other logit estimation packages such as SAS and STATA is that the algorithm includes a straightforward command for generating correct standard errors in the light of the two-stage estimation. (For details, see Greene, 1991.)

4. ADVANTAGES AND DISADVANTAGES OF LIMDEP ESTIMATION OF NESTED LOGITS

Limited information estimators are based on a single equation. It is a well-established result that with normally distributed disturbances, limited-information maximum likelihood estimation is efficient among single-equation estimators. On the other hand, full information estimators are based on the entire system of equation and treat all equations and parameters jointly. With normally distributed disturbances, full-information maximum likelihood estimators are efficient among all estimators. In nested logit estimation, particular correlation structures are assumed for errors within a partitioned subset in the limited-information estimation, while no such restriction would be imposed in full-information estimation.

Clearly, full-information estimators must dominate all other estimators asymptotically. However, as Greene (1993) points out, there are two problems with full-information estimators. First, should there occur any specification error in the structure of the model, it will tend to propagate through the system in case of full-information estimation. In contrast, in limited-information estimation, the specification error will be confined to the particular equation in which it appears. Second, the finite-sample variance of full-information estimators may be as large as, if not larger than, the limited-information estimators. The finite sample advantage may therefore be "more modest than the asymptotic results would suggest" (Greene, 1993).

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